

**SANDIA NATIONAL LABORATORIES
MICROFAB
DI POLISH, RO AND RECYCLE
DESIGN BUILD
PERFORMANCE SPECIFICATION
SECTION 15484S
12/26/02**

PART 1 – PERFORMANCE SPECIFICATION

1.1 GENERAL CONTRACT REQUIREMENTS

GENERAL CONTRACT REQUIREMENTS:

The General Contractor shall be responsible for the oversight of the complete design, installation, utility connections, commissioning and startup of the systems defined in this specification. All scheduling, submittals, changeorders, RFI's, jobsite supervision, coordination of subcontractors, etc. shall be the responsibility of the General Contractor. The scope of work in this specification includes specific requirements for the Design-Build of a new MicroFab DI Polish System, RO Transfer Pump System in Bldg. 858 for the MicroFab, a MicroFab Recycle System (including a new MicroFab recycle RO in Bldg. 858), and connections to the Bldg. 858 DI/RO/Recycle Systems and tanks. The General Contractor shall subcontract this scope of work to IONICS Pure Solutions of Phoenix, Arizona, who will perform all work defined in this specification. The General Contractor and Ionics shall coordinate the use of the necessary subcontractors to complete the work in this specification. The General Contractor shall be responsible for the DI, RO, Recycle, Acid Waste, Sanitary Sewer, HVAC, Plumbing and Process piping and distribution systems outside of the equipment skids (excluding interconnect piping between skids) at Bldg. 858 and at the MicroFab. The General Contractor shall be responsible for coordination with Ionics for installation of control and monitoring devices required for installation in the piping distribution systems.

Contract drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections (as listed below), apply to this scope of work. The General Contractor shall be responsible for ensuring that Ionics receives a complete set of bid documents prior to construction bid.

The following contract specifications and general requirements are applicable to this Design-Build Performance Specification.

1. 01065: ES&H for Construction and Service Contracts
2. 01300S: Descriptive Submittals
3. 01311S: Project Schedule
4. 01700: Contract Closeout
5. 01710S: Commissioning General Requirements
6. 01715S: Commissioning
7. 02222: Selective Demolition
8. 03300: Cast-In-Place Concrete
9. 07270: Firestop and Smokestop Systems
10. 07600S: Flashing and Sheetmetal
11. 07900S: Joint Sealants
12. 09900S: Painting
13. 13085S: Seismic Protection
14. 15050S: General Material & Work Requirements, Mechanical

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15. 15051S: Piping Systems
16. 15053S: Work in Existing Building
17. 15060S: Hangers and Supports
18. 15070S: Vibration Isolation
19. 15075S: Mechanical Identification
20. 15083S: Pipe and Equipment Insulation
21. 15090S: Polymer Process Piping Systems
22. 15121S: Expansion Compensation
23. 15130S: Pumps
24. 15170S: Motors
25. 15210S: Process Air and Gas Piping
26. 15233S: Acid Waste Piping
27. 15250S: Insulation-Mechanical Systems
28. 15401S: Plumbing
29. 15481S: Ultra High Purity Gas Distribution Systems
30. 15482S: Chemical Dispense and Distribution Systems
31. 15KS: Compressed Gas Piping Interior
32. 15540S: Centrifugal Pumps
33. 15710S: Heat Exchangers
34. 15901S: System Component Checkout and Balance
35. 15990S: Commissioning
36. 15994: Mechanical Systems Demonstrations
37. 15995S: Mechanical Systems Commissioning
38. 16001: Electrical Work
39. 16269S: Variable Frequency Controllers
40. 16441: Electrical Lighting and Appliance Panelboards
41. 16442: Electrical Power Panelboards
42. 16920S: Motor Control Centers
43. 16961S: Electrical System Testing and Startup
44. 16995S: Electrical Systems Commissioning

Ionics shall be responsible for reviewing these specifications, and incorporating them in the design and construction packages. The General Contractor shall be responsible for providing skilled, trained workers, experienced in working on jobs of similar size and complexity.

The following drawings are the minimum drawing requirements applicable to this specification. Ionics shall be responsible for obtaining the drawing files and updating them in the design phases of this performance specification from SNL. The following MicroFab Facility drawings shall be modified and as-built per Para 1.1B and C. Ionics shall assume that the following types of drawings in the Bid Package will need to be updated to show the new design of the systems. Drawing numbers for the following MicroFab drawings are defined in the Bid Package.

1. DI/RO Water Flow Diagrams
2. DI/RO Water Distribution Composite
3. DI/RO Water Distribution Plans, Areas 1C, D, E, F

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4. RO Water Flow Diagram
5. DI/Recycling Flow Diagram
6. DI/Recycling Plan Composite
7. DI/Recycle Plan, Areas 1C, D, E, F
8. Process Equipment Plan Composite
9. Process Equipment Plans, Areas 1C and 1E
10. Basement Area 1C and 1E Plumbing Floor Plans and Composite Floor Plan
11. Basement Mechanical Piping Plans, Areas 1C, 1E, and Composite Piping Plan
12. Low and Medium Temperature Chilled Water, and Hot Water Flow Diagrams
13. Basement Process Gases Plans, Areas 1C and 1E, and Composite Gas Plan
14. Basement Electrical Panel Schedules
15. One Line Diagram Process Loads, Building Loads, Panel Boards, MCC's
16. Basement Areas 1A, 1B, 1C and 1E Power Plans and Composite Power Plan

Ionics shall be responsible to obtain these drawings and modify them per Para 1.01 B and C.

The following drawings from the Bldg. 858 Facility drawing files shall be modified to incorporate the design requirements:

1. DQ1001858: 1st Floor Area 4A, Equipment Plan
2. DQ1002858: 1st Floor Area 4B, Equipment Plan
3. DP1001858: 1st Floor Area 4A, Piping Plan
4. DP1002858: 1st Floor Area 4B, Piping Plan
5. EP7005858: One Line Diagram, Sub 7/8/10
6. EP1001858: 1st Floor, Area 4A, Power Plan
7. EP1002858: 1ST Floor, Area 4B, Power Plan
8. EI7010858: MCC Schedules and Diagrams

In addition to the drawings listed in this section, the Ionics shall also be responsible for modifying and reissuing the existing Bldg. 858 DI Plant drawings by Ionics Pure Solutions, completed under the Bldg. 858 Upgrades Project in 2002-2003.

A. DESIGN REQUIREMENTS:

Ionics shall be responsible for the complete design of the new DI Polish, Recycle and RO Transfer Pump systems at the MicroFab, at the Bldg. 858 DI Plant, and the connections to existing Bldg. 858 systems. The complete design includes mechanical, electrical, controls, chemical and structural requirements to provide a fully operational system. The design shall

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incorporate the SNL standard and special specifications, and create additional specifications necessary for construction. The design team shall consist of at least a mechanical, electrical, and controls engineer to lead the design work. A structural engineer shall be provided as required for anchoring, support and seismic requirements. Structural engineering services shall be provided by the General Contractor with design input from Ionics. The lead engineers, fully responsible for the design, shall be current, registered professional engineers, and shall stamp the design package. Complete design calculations are required for each discipline, and shall be submitted at each design review milestone, as listed in the contract schedule.

The design engineers shall be responsible for understanding and applying the appropriate codes in their design. The construction documents shall be designed using the latest version of the International Building Code, International Fire Code, International Mechanical Code, International Plumbing Code, and the National Electric Code. CAD designer/drafters shall be familiar with Microstation, version J, as detailed in the next section. A complete design package will include drawings, specifications, calculations, sequence of operations, commissioning document, and panel schedules. The contractor shall meet with SNL in Albuquerque, on at least 3 occasions during the design phase to program and finalize design requirements (30%, 60% and 90% Design). Full size prints, design details, calculations and specifications shall be delivered to SNL at each design review, and for the final construction package. Reference the schedule in Section 1 of the contract for dates relating to the design and construction deliverables.

B. COMPUTER AIDED DESIGN REQUIREMENTS:

CAD drawings format after contract award shall be submitted in Micro Station version J per the SNL CAD standards. The contractor shall be responsible for modifying existing, updating new MicroFab drawings, and creating new CAD drawings per the SNL standards. The contractor shall review SNL CAD standards with the designated SNL CAD Representative prior to the start of design, and at the 30% design deliverable, to verify compliance with standards. The contractor shall plan on a one full day session with the CAD Representative at each meeting. The drawings shall be delivered to SNL on a CD-ROM disk at 30% and 100% design completions, and after the drawings are as built. As building of drawings during construction shall be the responsibility of the contractor.

1.2 GENERAL SYSTEM REQUIREMENTS

A. MICROFAB DI POLISH SYSTEM:

Ionics shall be responsible for the complete design and installation of a DI Polish System in the SubFab of the MicroFab. A complete design includes all structural, mechanical, process, chemical (if required), electrical and control systems. It shall include at a minimum, DI transfer pumps, an ultraviolet UV or TOC Destruct system, a plate and frame heat exchanger for temperature control, polishing mixed-bed deionizers, gas transfer membranes and vacuum pumps, polish loop booster pumps, ultra filtration and final cartridge filtration (if required) systems required to meet or exceed the DI Water Specifications listed at the end of this

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performance specification.

Ionics shall be responsible for the complete design and installation of DI transfer pumps at the Bldg. 858 DI Plant to pull water from the existing DI storage tanks and transfer the DI water to the new MicroFab DI Polish System. Ionics shall be responsible for connecting to the existing DI tanks at Bldg. 858. The General Contractor shall be responsible for the DI Loop piping, and the DIS/DIR piping between Bldg. 858 and the MicroFab, as shown on the design drawings.

Ionics shall be responsible for the complete design and installation of all mechanical, electrical, process and controls utilities to supply and operate the new MicroFab DI Polish System, from the Bldg. 858 and the MicroFab building systems.

Ionics shall be responsible for the MicroFab DI distribution loop flow and pressure controls, including the DI Polish boost pumps.

The MicroFab DI Polish Loop Flow shall have a maximum flow of 200 gpm. This is based upon a future total DI connected load of 315 gpm, and a 126 gpm peak consumption flow obtained from a 40% diversity. Therefore the DI transfer pumps and the DI Polish booster pumps shall be able to provide this flow and the pressure requirements listed above. The unused DIS water will return to the Bldg. 858 DI storage tanks.

At the outlet of the MicroFab Polish System, Ionics shall provide monitoring for TOC, Resistivity, Silica, flow, temperature, Dissolved Oxygen and particles. This monitoring shall be report back to the Bldg. 858 computer systems, and shall be read locally.

B. MICROFAB RECYCLE SYSTEM:

Ionics shall be responsible for the complete design of the MicroFab Recycle Water System in the SubFab of the MicroFab and at the Bldg. 858 DI Plant. A complete design includes all structural, mechanical, process, chemical (if required), electrical and controls systems to meet or exceed the Recycle Water requirements listed at the end of this specification. At a minimum the system shall include a 1,000 gallon double contained FRP collection tank with level control, 2 each Recycle Transfer Pumps, tank overflow and tank diversion piping systems to the MicroFab Acid Waste (AW) collection tank, installation of a Recycle RO (XRO) in the Bldg. 858 DI Plant at the existing Bldg. 858 XRO skid, fluoride monitoring, and all Recycle piping between the MicroFab and the Bldg. 858 DI Plant. The system shall be similar to the existing Bldg. 858 Recycle system.

The General Contractor shall be responsible for installing the Recycle drainage system including all piping and fittings, the Recycle tank, Recycle overflow and diversion piping, and all Recycle piping from the MicroFab to the Bldg. 858 XRO. Final connections at the Recycle Tank in the MicroFab and at the Bldg. 858 XRO shall be the responsibility of Ionics.

Ionics shall be responsible for the complete design and installation of all mechanical, electrical, process and controls to supply and operate the new MicroFab Recycle System, from the Bldg. 858 and the MicroFab building systems. The General Contractor and Ionics shall coordinate the point of connections of all utilities and the required building outages.

On the inlet Recycle drainage line to the Recycle Collection tank in the SubFab of the MicroFab,

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Ionics shall provide monitoring for TOC, pH, resistivity, flow and ORP. This monitoring shall report back to the Bldg. 858 computer systems, and shall be read locally. Ionics shall design a Recycle diversion and overflow system for the General Contractor to install prior to the Recycle Collection tank to divert the Recycle water to the MicroFab AW collection tank if the Recycle water does not meet established setpoints. Ionics shall establish these setpoints during the design of this system. As of this time, recycle water streams are expected to be similar to those at Bldg. 858. Ionics shall be responsible for the design and installation of the controls of these systems.

At the Recycle tank, the contractor shall provide new monitoring equipment to monitor for pH, ORP, Resistivity, tank level and Temperature. A 5-valve sample station manifold shall also be provided at the Recycle Tank. These monitors shall be used by the computer systems to divert the recycle waste streams after the Recycle tank to the AW collection tank if the Recycle water does not meet established setpoints. In addition the contractor shall provide a fluoride monitoring station to measure fluoride levels in the Recycle Tank, and divert to the AW collection tank at the appropriate levels.

The MicroFab Recycle System shall be designed for a maximum flow of 50 gpm back to the Bldg. 858 DI Plant.

C. MICROFAB RO SYSTEM:

Ionics shall be responsible for the complete design of the MicroFab RO Water Transfer Pump System at the Bldg. 858 DI Plant for the MicroFab RO system. A complete design includes all structural, mechanical, process, chemical, electrical and controls systems. At a minimum, the system shall include RO transfer pumps at the Bldg. 858 DI Plant, and all utility connections to the 858 DI Plant RO system. The General contractor shall be responsible for the RO piping at the MicroFab and between the MicroFab and Bldg. 858. The General Contractor shall also be responsible for the RO tank (1,880 gallon single-wall polypropylene), RO distribution pumps and controls, filtration, NPW redundant makeup, and an ultraviolet UV system for bacteria growth control. All RO pumps and the UV system shall have a 100% redundancy. The MicroFab RO loop demand shall be designed for a maximum of 35 gpm.

D. CONTROLS:

1. SNL will provide the available operational information on the existing DI Plant controls system to Ionics prior to bid or after contract award upon written request through the SCR. However, the identification of required points, design, installation, programming (Intellution HMI), upgrades to the existing system and startup of the control systems shall be the responsibility of Ionics and the General Contractor. Ionics shall review the existing site conditions prior to bid, and clearly understand what will be required to upgrade the existing systems. If the existing systems are found to be inadequate for expansion, Ionics shall notify the SCR prior to bid. Currently at Bldg. 858 there are two computers that run the DI Plant and the AWN

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systems. One computer is called a SCADA Node (view and control of both the DI Plant and the AWN), and the other is called a View Node (view only of the DI Plant system, view and control of the AWN system). Ionics shall design and install the necessary upgrades to make both computers operate as view and control for both the DI Plant and the AWN, so that there is a complete computer control redundancy. The current program software is FIX32, and the new system shall be programmed in IFIX. Ionics shall upgrade both computer systems to ensure this programming compatibility.

2. The controls for the new DI Polish, RO Transfer Pump System, and the Recycle Water System shall have their inputs and outputs routed to the existing SCADA Intellution HMI located in the Building 858 DI Plant. Systems can be controlled through local PLC's but all inputs and outputs (I/O) are to be mapped to a single register and brought over on a redundant data highway to the existing Intellution HMI, and must be compatible with the existing controls system. A ControlNet system is an acceptable alternative to the typical term "data highway" used by Allen Bradley. In the MicroFab SubFab, the Recycle and Polish System controls shall route to a local PLC with a computer and monitor. This station shall be set up as a view node. Control will be by the DI Plant SCADA system as stated above. Ionics shall be responsible for all of this work.
3. Ionics shall supply a listing of all control points, I/O location and logic diagrams and control drawings identifying the landing of each control point to the panel(s).
4. Ionics shall install all instrumentation with continuous side stream flow to minimize bacteria buildup. All controls and instrumentation shall not be installed directly into piping systems or fittings by drill and tap methods, but shall have suitable full line size fittings and reducers, or use threaded nipples and welded thread-o-lets prior to the instrument piping installation. Each item shall be isolated for service or replacement purposes. PVDF sample port fittings, manufactured by GE+ and Asahi, and designed to be drilled and tapped, are acceptable for high purity sample port instrumentation.

E. CHEMICALS:

The new Bulk Chemical Distribution System in the MicroFab at the North Process Support Area, and from the existing Bldg. 858 chemicals rooms West of the DI Plant, will supply both 50% Sodium Hydroxide and 93% Sulfuric Acid. The General Contractor shall be responsible for designing, supplying and installing a new chemical delivery system from the new bulk chemical storage room to the new DI Polish, RO and Recycle Systems for operations in the MicroFab if required. Ionics shall connect to newly installed points of connection in the MicroFab as provided by the General Contractor. Ionics shall connect to the existing Bldg. 858 system and route as required to the Recycle system in the Bldg. 858 DI Plant. There shall be a new chemical distribution system equipped with secondary containment and low point leak detection alarms. The chemical delivery system shall be a dual contained PVDF or polypropylene, continuous

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recirculation and heat traced system. It shall match the current Bldg. 858 system or the accepted system for the MicroFab.

F. VARIABLE FREQUENCY CONTROL (VFC):

All VFC's shall comply with specification 16269S. All power feeds to VFC's and other critical redundant equipment, such as pumps shall be fed such that a power surge or power interruption shall not take both the operating and standby system offline at the same time. VFC's shall be installed as required during design on the RO and DI transfer, booster and distribution pump systems. The VFC's shall not come with internal VFC bypasses since there will be 100% pump and VFC redundancy.

G. UTILITY OUTAGES:

All mechanical, electrical and controls connections (tie-ins) to existing utilities shall be performed during non-standard work hours on existing, operational systems, and shall be coordinated with the General Contractor and SNL. **UNDER NO CIRCUMSTANCE WILL ANY PORTION OF THIS DEFINED WORK IMPACT CURRENT MANUFACTURING PROCESSES AT BLDG. 858, UNLESS A SCHEDULED OUTAGE IS APPROVED BY SNL. OTHERWISE, IONICS AND THE GENERAL CONTRACTOR SHALL PROVIDE A SECONDARY MEANS TO ADEQUATELY KEEP THE 858 DI PLANT OPERATIONAL AT ALL TIMES DURING SCHEDULED OUTAGES.**

H. COMMISSIONING AND TEST AND BALANCE SERVICES:

The General Contractor and Ionics shall provide Commissioning and Test and Balance Services per the construction specifications listed at the beginning of this performance specification. The General Contractor and Ionics shall coordinate the test and balance, startup and commissioning of these systems. Test and Balance shall include verification of water, airflows and vibration to the requirements in this specification. Commissioning shall include all work necessary to start up and prove all specification requirements for complete and functional systems. Test and Balance, Commissioning and Utility Outages shall be part of the Construction Schedule, and shall be assigned in the Schedule of Values.

I. SUBMITTALS:

1. Submittals required after contract award. Provide the number of copies per Specification 01300, Descriptive Submittals. Most of the drawings required below (excluding control and flow diagrams) can be those requested under Para 1.1 of this specification. Submit on drawings and, major equipment and devices only.

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- a. Mechanical piping, plumbing, and controls plan showing location of equipment, and connection to equipment. Control plans shall be in P&ID format, with a complete sequence of operations for each subsystem.
- b. Mechanical, Controls details drawing(s) showing connection details for clarity in (a) above.
- c. Mechanical and Controls equipment schedules, detailing and specifying equipment and design basis.
- d. Equipment Plan drawings showing location and dimensions of equipment.
- e. Electrical Power plans showing location of equipment, and connection/homeruns to utility sources.
- f. Electrical One-Line Diagrams.
- g. Electrical MCC Diagrams and Schedules.
- h. Electrical Panel Schedules shall be updated for existing panels, and created for new panels, using SNL's standard Microsoft Excel template.
- i. Utility Outage and System Commissioning Document detailing the installation, construction phasing, and startup of systems. Startup plan shall include at a minimum the sterilization procedures, cleaning and flushing procedures, system filling procedures, automatic and manual valve positions, time schedules, etc. The Commissioning Document shall include procedures for sampling and analysis required to prove that the Polish, Recycle and RO systems meet the water quality specifications. SNL will provide spikes of Isopropyl Alcohol (IPA), Hydrogen Peroxide, Ethylene Glycol, TMAH, and Acetone to the recycle tank to verify that the Recycle System XRO removes or rejects these chemicals. Additional spike tests to be provided are Hydrochloric Acid, Sulfuric Acid, Phosphoric Acid, Nitric Acid, and Ammonium Hydroxide, designed to test the Recycle XRO diversion system.
- j. Equipment specifications and cut sheets on all new major equipment with the selected item marked. Equipment submittal shall include:
 - i. Descriptive literature
 - ii. Specifications
 - iii. Performance data sheets, pump and flow curves
 - iv. Make and Model
 - v. Utility services required
 - vi. Materials of Construction:

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- k. All new drawings or modified drawings shall be performed in Microstation, version J per SNL's CAD Standards.

2. OPERATION & MAINTENANCE MANUALS:

Upon completion of installation and prior to startup, provide the # copies per specification 01300, Descriptive Submittals. Each manual shall be bound in a hardbound, 3-ring notebook, and shall include the following information at a minimum:

- a. Diagrams and illustrations of all system components
- b. Detailed functional descriptions of each principal system component and control loop.
- c. Performance and nameplate data
- d. Operating data including flowrates, pressures, temperatures, etc.
- e. Installation instructions
- f. Startup procedures for each component and entire system
- g. Adjustment procedures
- h. Test Procedures
- i. Operating procedures for each component and entire system
- j. Shutdown procedures for each component and entire system
- k. Emergency operating procedures and troubleshooting guide.
- l. Safety precautions
- m. Maintenance and overall instructions, including detailed assembly drawings with part numbers, parts list, instructions for ordering spare parts, and complete preventative maintenance instructions including recommended frequency required to ensure performance and longevity of the equipment.
- n. Recommended spare parts list
- o. Lubrication instructions listing points to be greased or oiled, recommended type, grade and temperature range of lubricants, and recommended frequency of lubrication

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- p. List of electrical relay, control and alarm contact settings.
- q. Electrical interconnection wiring diagrams for the equipment including all control and lighting systems.
- r. System troubleshooting guides for operational problems (alarms)
- s. An overall detailed system description and operating instructions
- t. A complete set of system design as-builts of the P&ID, layout drawings, single line diagrams, control logic, system components, etc.

J. N+1 REDUNDANCY

Ionics and the General Contractor shall provide N+1 Redundant systems for the following items.

- 1. DI transfer pumps, DI Polish booster pumps, RO transfer pumps, Recycle Tank Lift pumps, and RO Loop pumps. VFC's used on pump systems shall also be redundant. Redundant VFC's do not require the internal bypass as specified in specification 16269S.
- 2. Ultrafiltration and Final Cartridge Filtration (if required)
- 3. Degasification (Gas Transfer Membranes and vacuum pump systems)
- 4. UV or TOC Destruct Systems
- 5. Polishing Deionization (Mixed Beds)
- 6. DI Polish and Recycle Water monitoring devices such as ORP, Resistivity, pH, Silica, Dissolved Oxygen, TOC and Particle Monitoring. Monitoring equipment shall have redundant spares instead of providing for redundant piping systems.

2.0 MATERIALS

A. Main DI Water Supply and Return Piping Between Buildings:

- 1. Pre-Polish System Piping:
 - a. Piping prior to Polish loop: PVDF material, installed in a minimum bead butt fusion fashion using infrared technology with a nitrogen purge. All PVDF is to be high purity (HP) material. Foreign material embedded in pipe wall or fittings will not be accepted.
 - b. Provide Asahi, Type AV, full face, PTFE coated gaskets, or equal, at flanges and butterfly valves installed in polish loop.
 - a. Expansion joints and/or flexible connectors to be from an owner-approved

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manufacturer composed of Teflon(R) (can be FEP or TFE) with maximum of two convolutions. The manufacturer's stated pressure rating must be proven adequate for gauge pressure at location in piping. Backing rings or metal reinforcement is prohibited.

2. Refer to Section 15090S for additional piping and valve specifications.

B. Polish Loop System:

2. Polish Loop and DI Distribution Piping:

- a. PVDF material, installed in a minimum bead butt fusion fashion using infrared technology with a nitrogen purge.
 - b. All PVDF is to be high purity (HP) material. Foreign material embedded in pipe wall or fittings will not be accepted.
 - c. Provide Asahi, Type AV, full face, PTFE coated gaskets, or equal, at flanges and butterfly valves installed in polish loop.
 - d. Cold DI Return System Piping: HP-PVDF pipe.
 - e. Expansion joints and/or flexible connectors to be from an owner-approved manufacturer composed of Teflon(R) (can be FEP or TFE) with maximum of two convolutions. The manufacturer's stated pressure rating must be proven adequate for gauge pressure at location in piping. Backing rings or metal reinforcement is prohibited.
3. Valves for takeoffs on supply line to different area:
- a. Cold UPW distribution main and sub-main take-off's to use HP-PVDF zero dead leg diaphragm valves by +GF+, Asahi, or equal for sizes up to 63 mm.
 - b. Cold UPW water takeoffs to use butterfly valves by Amri, or equal, with fully lugged bodies and PFA coated discs and PFA seats shall be used.

See Section 15090S for additional piping and valve specifications.

B. Recycle System:

1. Schedule 80 PVC from the Recycle Tank to the Bldg. 858 DI Plant XRO system (installed by the General Contractor with final connections by Ionics at the XRO). Recycle drainage piping from the MicroFab to the Recycle tank is shown elsewhere and is the responsibility of the General Contractor.

B. RO System:

2. Schedule 80 PVC from the Bldg. 858 RO system to the MicroFab RO tank (installed by the General Contractor with final connections in Bldg. 858 by Ionics). RO supply and return piping from and returned to the RO tank is shown elsewhere and is the responsibility of the General Contractor.

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2.1 EQUIPMENT

A. General

1. Do not use liquid level control, or liquid level indicator devices, which utilize sight glasses.

B. Monitoring

1. Provide following quality monitoring equipment with separate sampling line to continuously monitor water parameters:
 - a. Pressure
 - b. Temperature
 - c. Resistivity
 - d. Particles
 - e. TOC
 - f. ORP
 - g. Silica
 - h. Flow
 - i. Dissolved Oxygen
 - j. pH

C. Pre-Polish and Polish System:

1. Pumps:
 - a. DI transfer and polishing loop boost pump: Provide Goulds or equal, 316 Stainless Steel pumps with premium efficiency motors. Minimum pump efficiency to be 80 percent at design conditions. Motors must be rated for inverter duty suitable for VFC's.
 - b. Install pump on inertia pad with vibration isolators (inertia base with springs and snubbers in vibration sensitive areas). Provide each pump inlet and discharge pipe with a bellows type vibration isolator.
 - c. Centrifugal Pumps: Refer to Section 15540S.
2. Motors: Refer to Section 15170S.
3. Motor Starters: Refer to Section 16001S.
 - a. Provide low-pressure cut-off.
4. Ultraviolet Sterilization:
 - a. UV units to have flanged connections with sample ports at inlet and outlet.
 - b. UV units to be by Aquafine, or equal, and constructed of electropolished 316L SS

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with fused quartz for the sleeves. TOC Destruct units by Advanced UV are acceptable for the Polish System.

- c. UV units to have an hour meter and an intensity meter.
- d. Provide a redundant UV unit for maintenance purposes.
- e. Allow space for the removal of the UV lamps and quartz sleeves from both ends.
- f. Provide valving for maintenance.
- g. Install the light trap.

5. Heat Exchangers:

- a. All heat exchangers are to be plate and frame type heat exchangers with 316L EP surfaces for DI water service and 316L SS surfaces for hot/cold water service. Expanded PTFE gaskets by W.L. Gore, or equal are to be used.
- b. Approved Manufacturers:
 - a) Tranter.
 - b) Bell & Gossett.
 - c) Alfa-Laval.

Substitutions: Under provisions of Section 01300.

6. Waste Lift Pump:

- a. Provide duplex sump pump system, level controls and piping at the MicroFab Polish System to lift spill to the acid waste collection tank. Pumps to be installed in recessed floor sump (floor sump provided by others) and operated automatically. Leak sensor in the sump shall be provided.

7. Ion Exchange:

- a. Provide 60 mils (1.5 mm) ETFE lined carbon steel vessels for final ion exchange polishing step.
- b. Replaceable cartridges are not acceptable as final ion exchange vessels.
- c. Ion exchange resins to be of type that is readily available.

8. Filtration:

- a. Ultra Filtration and Final Filtration (if required) per Ionics, and approved by SNL to meet the DI Water Specification for Final Polish.

D. Recycle and RO System:

1. Pumps:

- a. RO water transfer and Recycle Transfer pumps: Provide Grundfos, or equal, 316 Stainless Steel pumps with premium efficiency motors. Minimum pump efficiency to be 80 percent at design conditions. Motors must be rated for inverter

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- duty suitable for VFC's.
- b. Install pump on inertia pad with vibration isolators (inertia base with springs and snubbers in vibration sensitive areas). Provide each pump inlet and discharge pipe with a bellows type vibration isolator.
 - c. Centrifugal Pumps: Refer to Section 15540S.
2. Motors: Refer to Section 15170S.
3. Motor Starters: Refer to Section 16001S.
- a. Provide low-pressure cut-off.
4. Recycle Collection and RO tanks:
- a. Provide continuous level controls, low and high level alarms and instrumentation for monitoring tank level (Ionics is responsible for the Recycle Tank, and the General Contractor is responsible for the RO Tank controls).
 - b. Provide vortex breaker at tank discharge to minimize any disturbances in flow to pump suctions.
 - c. Tanks must be rated for the working pressure of system.
 - d. Provide a minimum 18" diameter top access manway, and cover for tank maintenance
 - e. Provide flange connections for piping and chemical injection
 - f. Provide drain valve.
 - g. FRP construction, double contained, 1,000 gal for Recycle. 1,880 gal single wall, polypropylene for the RO. Tanks furnished and installed by the General Contractor. Ionics shall be responsible for the controls and pumps at the Recycle Tank, and RO makeup water controls to the RO Tank.

2.6 ELECTRICAL EQUIPMENT

A. Electrical Components to conform to Division 16, "Electrical." All conduits shall be PVC around chemical distribution piping, or at equipment skids using chemicals.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Installation of instrumentation and controls equipment
- 1. Field installed transmitters, including pressure, temperature, flow, and others, to be easily accessible for calibration purposes. For each unit process with instrumentation, construct avrack on which all instrumentation will be mounted to provide a safe and

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accessible working location. Multi-plexing groups of similar instrumentation are acceptable.

2. Follow directions for spacing of transmitters and sensors with leading pipe diameters of straight length before and after where required.
3. Equip pressure transmitters with calibration header constructed from SS tubing.
4. Loss of signal or air pressure on pneumatically controlled valves to cause valves in main process stream to remain in their current position. Other valves to fail in closed position.
5. TOC and Silica Monitoring to be installed:
 - a. After last unit process in polish loop.
6. Resistivity and Dissolved Oxygen Monitoring to be installed:
 - a. After last unit process in polish loop.
7. Particle Monitoring to be installed as follows:
 - a. After the last unit process in the polish loop.
8. Flow rate Monitoring to be installed as follows:
 - a. On feed to polish loop and after the last unit process in the polish loop.
9. ORP Monitoring to be installed:
 - a. After last unit process in polish loop.
10. Temperature Monitoring to be installed as follows:
 - a. Before and after any heat exchange device.
 - b. After last unit process in the polish loop.
11. Pressure Monitoring to be installed as follows:
 - a. After last unit process in polish loop.
 - b. On the return water distribution system.
 - c. At filter inlet and outlet headers.
 - d. At mixed bed inlet and outlet headers.

B. Installation of piping and valves

1. Support piping systems and install per specification 13085S, 15050S, 15051S, 15060S, and 15090S depending upon piping system installed.
2. Valves and analytical equipment are required to be on independent rack or supports with seismic bracing where applicable.
3. Install mains and submains within piping hierarchy.
4. Provide and install equipment, piping, tanks, pipe supports, electrical distribution, cable trays, instrumentation within primary and polishing plants.

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5. Install jumpers between supply and return at future submain valves and future equipment connections to ensure continuous flow. Maintain minimum flow required in piping to prevent bacterial growth in cold distribution piping.
 6. Equip each cold DI submain with sample port for ozone sterilization and bacterial analyses.
 7. Provide resin traps on outlet piping of ion exchange vessels.
 8. Perform any primary ion exchange resin conditioning outside of ultrapure water plant. Manufacturer or supplier prior to loading into process vessels will condition ion exchange resin.
 9. Provide numbering and labeling system for identification of valving, vessels, pumps, and face piping for each unit process in accordance with Sections 15050S, 15051S, 15075S and 15090S.
 10. Install sample ports at each unit process.
 11. Provide flanges throughout the DI water plant and polish loop for ease of installation and repair.
 12. Minimize dead legs in piping systems for Make-up Plant, Polish system, Polish distribution system and DI reclaim system.
- C. Installation of electrical
1. Provide emergency power for the polish loop system pumps as follows. At least one DI transfer and booster pump on polish loop system shall be connected to emergency power.
 2. Provide labeling for all circuits in accordance Section 16001S. Show power source, including panel name, circuit breaker and location.
 3. Provide water-proof electrical enclosures in DI Plant and polish area.

3.2 FIELD QUALITY CONTROL

- A. Pressure test lines per the mechanical specifications for each type of piping system. Hydrotest procedures shall be developed during the design phase of this project and approved by SNL.
- B. Submit required copies of all test and start-up documentation, owner's manuals, operations manuals, and as built drawings at completion of project.
- C. Demonstrate automatic pump rotation and pump failure modes for all pumps.
- D. Provide power consumption, pump performance and heat exchanger performance at design conditions.
- E. Provide and execute training as specified under Submittals.
- F. Spark test lined vessels. Provide documentation to the SDR.

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- G. Provide matrix showing electrical power sources for each piece of equipment in both DI water plant and polish loop.

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TABLE 1: EXISTING BLDG. 858 WELL WATER ANALYSIS

The following parameters are typical of the well water to be treated

Temperature is 16 – 25 Degree

Celsius

Analytical Parameters	Units	3/11/01	8/16/01	11/14/01	1/24/02
Turbidity	NTU	0.6	NM	0.3	NM
Conductivity	Mhos/cm	312	354	346	387
pH	pH	8.1	8.2	8.2	8.1
TDS (Estimated)	mg/l	249	258	231	296.2
Total Hardness (CaCO ₃)	mg/l	124	123	122	118
Total Hardness (CaCO ₃)	grains/gal	7.3	7.2	7.1	6.9
TOC	mg/l	0.12	0.16	0.63	0.19
Total Alkalinity (as CaCO ₃)	mg/l	NA	NA	NA	NA
Cations					
Calcium (Ca) (as element)	mg/l	39.6	37.4	39	34.8
Calcium (Ca) (as CaCO ₃)	mg/l	99.5	93.5	97.5	87
Magnesium (Mg) (as element)	mg/l	6	7.2	6	7.5
Magnesium (Mg) (as CaCO ₃)	mg/l	24.7	29.7	24.7	30.9
Sodium (Na) (as element)	mg/l	25.9	24	26.5	29.7
Sodium (Na) (as CaCO ₃)	mg/l	56.2	52.3	57.8	64.7
Potassium (K) (as element)	mg/l	3.4	3.8	3.6	5.5
Potassium (K) (as CaCO ₃)	mg/l	4.4	4.9	4.6	7
Strontium (Sr)(as element)	mg/l	0.41	0.36	0.37	0.4
Strontium (Sr)(as CaCO ₃)	mg/l	0.5	0.5	0.5	0.5
Barium (Ba)(as element)	mg/l	0.14	0.1198	0.37	0.1316
Iron (Fe)	mg/l	ND	ND	ND	ND

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Manganese (Mn)	mg/l	ND	ND	ND	ND
Copper (Cu)	mg/l	ND	0.004	ND	0.005
Zinc(Zn)	mg/l	ND	ND	ND	ND
Anions					
Chloride (Cl) (as element)	mg/l	42.2	25.6	41.1	40.8
Nitrate/Nitrite (as element)	mg/l	ND	0.2	0.2	0.8
Sulfate (SO4) (as element)	mg/l	29	34	29	31
Bicarbonate (as element)	mg/l	94.5	103.2	87.2	89
Fluoride (F) (as element)	mg/l	0.4	0.6	0.4	0.5
Silica (SiO2) (as element)	mg/l	41	45.8	44.2	64

TABLE 2: EXISTING BLDG. 858 RECYCLE WATER ANALYSIS

RECYCLE WATER ANALYSIS		
The following analysis shows the parameters of the water that will be assumed to be applicable for the MicroFab Recycle System.		
Analytical Parameters	Units	Recycle Water Stream
Resistivity	Kohm/cm	2 to 200
Dissolved Silica (SiO2)	Ppb	3 to 30
TOC	Ppb	5 to 200
Dissolved Oxygen (DO)	Ppb	>5500
pH	PH	2 to 10

TABLE 3: DI WATER STANDARDS AT BLDG. 858 DI TANKS (PRE-POLISH LOOP)

Water Treatment Standards

The following are the standards that need to be met after R/O and after Mixedbeds

Analytical Parameters	Units	R/O Product Water	Post Mixedbed or EDI Water	Procedure
Rejection	%	>98.5		Thornton 770 Max
Resistivity	Megohm/cm		= or >18.0	Thornton 770 Max
Total Hardness	ppb		ND	

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(CaCO ₃)				
TOC	ppb		<2	Sievers TOC PPT
Dissolved Silica (SiO ₂)	ppb		<1	Hach Series 5000
pH			6 TO 8	Thornton 770 Max
Dissolved Oxygen	ppb		<10	Orbisphere 3660
Bacteria	cfu/100ml		<1	Balaz Test W0102
Total Silica	ppb		<2	Balaz Test W0120
Fluoride	(F ⁻) ppb		<1	Balaz Test W0121
Chloride	(Cl ⁻) ppb		<1	"
Nitrite	(NO ₂ ⁻) ppb		<1	"
Bromide	(Br ⁻) ppb		<1	"
Nitrate	(NO ₃ ⁻) ppb		<1	"
Sulfate	(SO ₄ ⁼) ppb		<1	"
Phosphate	(PO ₄ ³⁻) ppb		<1	"
Lithium	(Li ⁺) ppb		<1	Balaz Test W0122
Sodium	(Na ⁺) ppb		<1	"
Ammonia	(NH ₄ ⁺) ppb		<1	"
Potassium	(K ⁺) ppb		<1	"
Magnesium	(Mg ⁺⁺) ppb		<1	"
Calcium	(Ca ⁺⁺) ppb		<1	"
Temperature	Degrees Celsius		25	

Note:

Balaz Test W0102: Bacteria ASTM Method-48 Hr Incubation
Balaz Test W1020: Total Silica
Balaz Test W0121: Anions by IC (Ultrapure)
Balaz Test W0122: Cations by IC (Ultrapure)

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TABLE 4: DI WATER POLISH LOOP SPECIFICATION FOR THE MICROFAB

Parameter	DI Water Spec Modified ASTM D 5127 – 98E - 1.1)
Line width microns	0.25-0.5
Resistivity * Megohm/cm @ 25° C	18.2
Total organic compounds (TOC) parts per billion (ppb) *	2
Dissolved O2 ppb *	5
Laser (particles/L) *	
Microns .05 – 0.1*	500
Microns 0.1 – 0.2*	300
Microns 0.2 – 0.3*	50
Microns 0.3 – 0.5*	20
Microns > 0.5*	4
Bacteria/L	10
Total Silica ppt	1000
Reactive Silica ppt *	500
Non-volatile residue (NVR) ppb	< 1